

Bredin, Don; Hyde, Stuart

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## Investigating sources of unanticipated exposure in industry stock returns

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# Working Paper Series

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Don Bredin and Stuart Hyde

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The University of Manchester  
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Manchester M15 6PB

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## Author(s) and affiliation

Don Bredin  
School of Business  
University College Dublin  
Blackrock  
Dublin 4  
Ireland  
Tel: +353 1 716 8833  
Fax: +353 1 283 5482  
E-Mail: [don.bredin@ucd.ie](mailto:don.bredin@ucd.ie)

Stuart Hyde  
Manchester Business School  
University of Manchester  
MBS Crawford House  
Booth Street East  
Manchester M13 9PL  
UK  
Tel : +44 161 275 4071  
Fax : +44 161 275 4023  
E-Mail : [stuart.hyde@mbs.ac.uk](mailto:stuart.hyde@mbs.ac.uk)

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# Investigating Sources of Unanticipated Exposure in Industry Stock Returns

Don Bredin  
University College Dublin \*

Stuart Hyde  
University of Manchester<sup>†</sup>

## Abstract

This paper investigates the sources of both foreign exchange rate and interest rate exposure of industry level portfolios in the G7, decomposing exposure into cash flow and discount rate effects. Initial examination of the degree of exposure on industry returns produces results consistent with the prior literature: that there is little evidence of exchange rate exposure in most industries – the *exchange rate exposure puzzle*. However, rather than relying solely on the sensitivity of industry returns, we examine the cash flow sensitivity to foreign exchange exposure, of primary interest to firm managers. Critically, decomposing the exposure into cash flow and discount rate components unlocks the exact extent and nature of exposure. Our results show industries have significant cash flow and discount rate exposures. These exposures increase with the level of trade openness and the spread between permanent cash flow exposure and transitory discount rate exposure widens.

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\***Corresponding author:** Don Bredin, School of Business, University College Dublin, Blackrock, Dublin 4, Ireland. Tel: +353 1 716 8833. Fax: +353 1 283 5482. E-mail: don.bredin@ucd.ie. The authors would like to thank participants at the 2009 INFINITI Conference at Trinity College Dublin and Colm Kearney in particular for helpful comments.

<sup>†</sup>Stuart Hyde, Manchester Business School, University of Manchester, MBS Crawford House, Booth Street East, Manchester, UK M13 9PL. Tel: +44 161 275 4017. Fax: +44 161 275 4023. E-mail: stuart.hyde@mbs.ac.uk

# 1 Introduction

According to financial theory changes in exchange rates and interest rates should affect the value of the firm. Exchange (interest) rate exposure refers to the extent to which the value of the firm is affected by changes in exchange (interest) rates. The issue of exposure to both exchange rate and interest rate risk is of importance to individual investors and firms. For example, changes in exchange rates and interest rates affect an investor holding a portfolio consisting of securities from different countries. While changes in exchange rates naturally impact the cash flows of multinational firms with operations in different foreign locations, importers and exporters and even solely domestic firms through changes in the competitive environment and the terms of trade. Bodnar et al. (2002) and Hutson and Stevenson (2010) highlight that while local firms may not trade internationally, they may still be exposed to changes in exchange rates, if for example they are in competition with foreign firms in the domestic market.<sup>1</sup> Hence there has been much interest in evaluating the level of exchange rate exposure a firm or industry faces. Similarly changes in interest rates will alter the firms' financing costs, affecting the amount of loan interest and principal payments and impacting cash flows of the firm. However, the vast majority of recent studies assessing exposure focus solely on foreign exchange exposure and relatively few take account of interest rate exposure.<sup>2</sup>

In this paper we examine the level of exposure faced by industries to both interest rate and foreign exchange rate risk across all G7 countries using a different methodology to the previous studies in the literature. Analysing industry exposure is important since industries differ in terms of pass through and mark-ups (Bodnar et al., 2002; Allayannis and Ihrig, 2001), competitive structure (Marston, 2001; Williamson, 2001; Griffin and Stulz, 2001) or industry concentration (Bartram and Karolyi, 2006) and hence may face different levels of exposure. Our approach to the measurement of unexpected exposure differs to the majority of the extant literature. Only unanticipated levels of exposure should influence firm or industry portfolio prices immediately, anticipated changes in exposure should have no affect and should already be priced into the asset by market participants. Hence the unexpected component of foreign exchange (interest rate) movements is a more appropriate measure to examine the extent of exposure. Yet, many studies adopt realized or actual changes in exchange rates as the proxy for unexpected changes (e.g. Jorion, 1990; Bodnar and Gentry, 1993; Choi and Prasad, 1995; Chow et al., 1997) despite the actual change consisting of both an expected and unexpected component. Analogous to Amihud (1994) who proposes a two stage estimation approach, Choi et al. (1992) who utilise ARIMA models and Gao (2000) who adopts a macroeconomic model to generate unexpected changes in exchange rates we employ a different econometric approach, a vector autoregressive model, to generate unanticipated changes in exchange rates.

The key distinction between our paper and previous studies is that we also identify the sources of any possible exposure. Standard textbook definitions of foreign exchange exposure state that "transaction and operating exposure exist because of unexpected changes in future cash flows" (Eiteman et al., 2010, p.283). Managers will therefore be particularly interested in the exposure measure that identifies the cash flow sensitivity to exchange rate movements.

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<sup>1</sup>Such firms may, in fact, face greater exposure since they do not have operational hedges and are unlikely to engage in financial hedging (Dominguez and Tesar, 2001a,b).

<sup>2</sup>Bartram and Bodnar (2007) review the exchange rate exposure literature. Limited evidence on interest rate exposure is provided by Sweeney and Warga (1986), Madura and Zarruk (1995) while Prasad and Rajan (1995), Choi et al. (1992) and Choi and Elyasiani (1997) simultaneously take account of both exchange rate and interest rate risk finding mixed levels of exposure.

From the theoretical perspective a large number of studies highlight the aim of the firm to manage cash flow movements, (e.g. Stulz (1984) and Smith and Stulz (1985)). Empirically, Bodnar and Marston (1996), using survey data, highlight that managers are considerably more interested in keeping cash flows stable, rather than firm value in the light of foreign exchange rate movements. While Bartram (2008), using proprietary firm data, illustrates operating cash flows are significantly exposed to exchange rate changes. The alternative is to model the extent of the exposure by examining the change in the market value of the firm or industry as a result of a change in the exchange rate. This approach has been developed by Adler and Dumas (1984) and Hekman (1985) and extended by Jorion (1990) has become extremely popular given the simplicity associated with using market data to determine the extent of exposure. However, the majority of literature has typically established low levels of significant exposure giving rise to the *foreign exchange exposure puzzle*.<sup>3</sup>

A potential implication of the empirical findings to date is that firm value is not exposed to foreign exchange movements, implying that firms successfully handle exposure via pass-through, operational or financial hedging. Bartram et al. (2010) show that the combination of these factors significantly reduces the level of observed exposure. Choi and Kim (2003) argue that operational strategies as well as financial hedging alter the exposure profile of firms.<sup>4</sup> Yet the market value approach results may be unreliable for two further reasons. First, Chow et al. (1997) argue that although foreign exchange exposure relates distinctly to cash flows, stock returns embed both cash flow and interest rate effects which may produce offsetting effects masking the actual level of exposure. Naturally the value of industry returns may fall either because exchange rates affect expected cash flows, the discount rate or cost of capital applied to the cash flows changes. Bodnar and Wong (2003) further illustrate the significance of these interaction effects. Additionally, Bartram (2004) indicates that foreign exchange rate exposure effects are likely to be non-linear and that this may be as a result of cash flows being a non-linear function of foreign exchange rates. Second, while it may be feasible that a successful hedging strategy is adopted for current cash flows, this is unlikely to be the case for future cash flows. Chow et al. (1997) highlight the difficulty associated with stabilizing future cash flows in the face of foreign exchange movements using hedging instruments.

Here, we first highlight the empirical evidence of the puzzle, adopting the market value approach, then we formally examine the components of industry return exposure, namely cash flows and interest rates (discount rates). Thus we isolate the exposure of principal interest to managers, the cash flow effects representing transaction and operating exposure, and also examine the relationship to any interest rate effect. Finally and most importantly, our identification extends Chow et al. (1997) in that we examine the *future* cash flow effects and specifically whether there is a complementary effect with the *future* interest rate channel. We use the rational valuation formula (RVF) for stock prices as our starting point to analyse the unexpected exposures.<sup>5</sup> The RVF states that prices will equal the discounted present

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<sup>3</sup>For example, Jorion (1990), Bodnar and Gentry (1993), Amihud (1994), Choi and Prasad (1995) and Chow et al. (1997). See Muller and Verschoor (2006) and Bartram and Bodnar (2007) for comprehensive surveys.

<sup>4</sup>Further evidence is provided by Pantzalis et al. (2001) and Choi and Jiang (2009) in this regard, showing that exposures are smaller and less significant for multinational firms (i.e. those that engage in operational hedging) while Kim et al. (2006) show non-operationally hedged firms tend to make greater use of financial hedging.

<sup>5</sup>For robustness and comparison with the existing literature we also report results from the Jorion (1990) model in Section 3.3.

value of future dividends (cash flows) and discount rates. The metric we employ draws on the multi factor asset pricing model, the arbitrage pricing theory (APT), which indicates the sensitivity of the portfolio ( $\beta$ ) to the particular factor (foreign exchange or interest rate). It is this approach that leads to the identification of the cash flow and interest rate components of exposure.

Our results for the direct effects of both foreign exchange and interest rate exposure applied to industrial sectors in the G7 are weak, but fully consistent with those found previously in the literature. Although we find limited evidence of foreign exchange exposure, the findings are generally consistent with the openness of the market, with France, Italy, Germany and Canada indicating some exposure. However, it is only when we decompose the channels that we identify the full extent of foreign exchange and interest rate exposure. The first point to note is that exchange rate exposure is evident for the vast majority of G7 countries and industries. Our results are also intuitively appealing. Open markets such as France, Germany and Italy are particularly exposed to movements in foreign exchange. However, we also find that all U.S. and Japanese industries in our sample are exposed to foreign exchange movements. Although, the levels of the exposure faced by the U.S. and Japan are relatively low compared to more open markets, they are none the less statistically significant. Our results are consistent with the previous findings on the link between openness and exposure and in particular that smaller and more open markets also have the largest dispersion in inter-industry foreign exchange exposure (see He and Ng, 1998; Nydahl, 1999; Friberg and Nydahl, 1999; Hutson and Stevenson, 2010). In particular, Hutson and Stevenson (2010) provide a detailed and large sample analysis across 23 developed countries finding consistent evidence of a positive relationship between openness and foreign exchange exposure, using a number of openness proxies. Our results indicate the dominant role played by the cash flow channel and the particularly large divergence in relation to the discount rate channel, the more open the market.

The formal identification of the channels of foreign exchange exposure will be of interest to both international investors and corporate managers. Investors concern in relation to unexpected changes in foreign exchange is driven by the potential impact on industry portfolio values. Our results indicate the dominant role played by the cash flow channel, compared to the discount rate channel. For the investor the implications of our results are that the permanent effects on wealth are greater than the transitory effects on wealth and so future investment opportunities are reduced. Campbell and Vuolteenaho (2004) refer to this as the ‘bad’ beta outweighing the ‘good’ beta. From the corporate managers perspective, our results highlight the significant role played by both transaction and operating exposure via the cash flow channel, in particular for open markets. However, more importantly, our results indicate the influence of foreign exchange exposure on future cash flows which is consistent with firms’ difficulty in hedging future flows. Particularly, given the difficulty associated with hedging operating exposure relative to transaction exposure, our cash flow channel is likely to represent the extent of the operating exposure. The role played by operating exposure is consistent with the Campbell-Vuolteenaho permanent effects.

The remainder of the paper is set out as follows: section 2 introduces the modeling framework; the standard model, the Campbell decomposition and the forecasting approach. Section 3 discusses the data and empirical results and section 4 provides some concluding comments.

## 2 Theoretical Framework & Exposure Metrics

### 2.1 Campbell Decomposition

The standard starting point that has been adopted by the literature has been the Jorion (1990) approach;

$$R_{it} = \beta_0 + \beta_1 \Delta s_t + \beta_2 R_{mt} + \varepsilon_{it} \quad (1)$$

where  $\beta_0$  is a constant term,  $R_{it}$  denotes the return on security/portfolio  $i$  in period  $t$ ,  $\Delta s_t$  is the contemporaneous change in the real exchange rate,  $R_{mt}$  is the return on the market and  $\varepsilon_{it}$  is an error term.  $\beta_1$  captures the ‘residual’ exposure elasticity since it captures the exposure of the firm/industry controlling for market wide exposure. Rather than focusing solely on foreign exchange exposure, this model can be augmented to take into account a comprehensive set of exposures, i.e. market, foreign exchange and interest rate exposure. Equation (1) is extended to include changes in real interest rates,  $\Delta i_t$ :

$$R_{it} = \beta_0 + \beta_1 \Delta s_t + \beta_2 R_{mt} + \beta_3 \Delta i_t + \varepsilon_{it} \quad (2)$$

Models of the form of Equation (2) can be viewed as extensions of the basic market model or CAPM to a three factor model. Similarly, a linear factor model (Burmeister and McElroy, 1988) is used to justify the use of market returns, interest rates and exchange rates as factors in the estimation of a model of state variables that impact all industry sectors. The log-linear representation of the present value model formulated by Campbell and Shiller (1988) approximates the one-period log holding. Using the framework developed by Campbell (1991) it is possible to obtain a decomposition of the unexpected portfolio return (a detailed derivation is provided in appendix 1):

$$\begin{aligned} \tilde{e}_{i,t+1} &= (E_{t+1} - E_t) \left\{ \sum_{j=0}^{\infty} \rho^j \Delta d_{i,t+j+1} - \sum_{j=0}^{\infty} \rho^j r_{i,t+j+1} - \sum_{j=1}^{\infty} \rho^j e_{i,t+j+1} \right\} \\ &= \tilde{e}_{di,t+1} - \tilde{e}_{ri,t+1} - \tilde{e}_{ei,t+1} \end{aligned} \quad (3)$$

where  $\rho_i$  is  $1/(1 + \exp(\delta_i))$ . The decomposition states that the unexpected excess return on portfolio  $i$ ,  $\tilde{e}_{i,t+1}$  is equal to the news about future dividends on portfolio  $i$ ,  $\tilde{e}_{di,t+1}$  (related to cyclical economic effects), minus the news about future real interest rates,  $\tilde{e}_{ri,t+1}$  (related to monetary policy effects), and the news about future excess returns,  $\tilde{e}_{ei,t+1}$  (related to risk premiums).

The sensitivity (beta) decomposition is defined by using the unconditional variances and covariances of the innovations in returns and factors. The beta with respect to the  $k$ th factor (e.g. exchange rate or interest rate changes) is defined as:

$$\beta_{i,k} = \frac{\text{cov}(\tilde{e}_i, \tilde{e}_k)}{\text{var}(\tilde{e}_k)} \quad (4)$$



which is simply the covariance between the unexpected excess return on portfolio or industry  $i$ ,  $\tilde{e}_i$ , and the unexpected excess return on factor  $k$ ,  $\tilde{e}_k$ , divided by the variance of the unexpected excess return on the  $k$ th factor.  $\beta_{i,k}$  can then be decomposed into:

$$\begin{aligned}\beta_{i,k} &= \frac{\text{cov}(\tilde{e}_{di}, \tilde{e}_k)}{\text{var}(\tilde{e}_k)} - \frac{\text{cov}(\tilde{e}_{ri}, \tilde{e}_k)}{\text{var}(\tilde{e}_k)} - \frac{\text{cov}(\tilde{e}_{ei}, \tilde{e}_k)}{\text{var}(\tilde{e}_k)} \\ &= \beta_{di,k} - \beta_{ri,k} - \beta_{ei,k}\end{aligned}\tag{5}$$

where  $\beta_{di,k}$  is the beta between the innovation in the  $k^{th}$  factor (e.g. exchange rate changes) and news about portfolio  $i$ 's future cash flows or dividends,  $\beta_{ri,k}$  is the beta between the innovation in the  $k^{th}$  factor and news about future real interest rates and  $\beta_{ei,k}$  is the beta between the innovation in the  $k^{th}$  factor and news about future industry excess returns. Given that we take both a cross country and industry perspective to identify the level of exposure, our  $\beta$  terms in relation to foreign exchange rate exposure may have very different interpretations. Commonalities in the cash flow  $\beta$  for the same industries across different countries is likely to indicate the exposure of profits to exchange rate movements. While for industries in the same country the cash flow factor may indicate the importance of national macroeconomic issues. The exposure of industries in the same countries may also feed through via discount rates and imply country specific factors. Finally, common industries across different countries are likely to imply common risk premium effects.<sup>6</sup>

## 2.2 Forecasting Approach

In order to estimate the beta decomposition, it is necessary to construct empirical proxies for the news about future cash flows, excess returns and real interest rates. The excess return on each portfolio  $\mathbf{e}_i$  under consideration is assumed to be a linear function of the chosen  $l$  state variables  $\mathbf{x}_t$  (here  $l = 3$ ) which are known to all participants in the market and which provide a summary of the state of the economy at the end of period  $t$ :<sup>7</sup>

$$\mathbf{e}_{i,t+1} = \mathbf{a}_i \mathbf{x}_t + \tilde{\mathbf{e}}_{i,t+1}\tag{6}$$

where  $\tilde{\mathbf{e}}_i$  is the  $i$ th row of the vector  $\tilde{\mathbf{e}}$  and  $\mathbf{a}_i$  is the  $i$ th row of the  $l$  element coefficient vector. The state variables are assumed to be the real stock market excess return and changes in the real exchange rate and the real interest rate. Additionally, the vector of state variables is assumed to follow a first order vector autoregression (VAR) process:<sup>8</sup>

$$\mathbf{x}_{t+1} = \mathbf{\Pi} \mathbf{x}_t + \tilde{\mathbf{x}}_{t+1}\tag{7}$$

where  $\tilde{\mathbf{x}}_{t+1}$  is the innovation in the vector of state variables. Hence the expectation in the current period of any future values of the state variables is:

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<sup>6</sup>Ammer and Wongswan (2007) apply a similar approach to investigate industry and country effects to international stock market integration.

<sup>7</sup>The terms in bold represent a vector/matrix.

<sup>8</sup>We tested the lag length in the VAR using the standard information criteria, Akaike information (AIC) and Schwartz Bayesian (SBC) and found a lag length of one. This is consistent with studies that have adopted this approach in the asset pricing literature, (see Cuthbertson and Nitzsche, 2005).

$$E_t \mathbf{x}_{t+j+1} = \mathbf{\Pi}^{j+1} \mathbf{x}_t \quad (8)$$

and the revision in long horizon expectations of  $\mathbf{x}_t$  made between the current period and the next is:

$$(E_{t+1} - E_t) \mathbf{x}_{t+j+1} = \mathbf{\Pi}^j \tilde{\mathbf{x}}_{t+1} \quad (9)$$

Using the definitions of the news variables in Equation (5) and the revision of expectations in the vector of state variables in Equation (9), it is possible to derive the ‘news’ components of the portfolio returns:

$$\begin{aligned} \tilde{\mathbf{e}}_{di} &= \tilde{\mathbf{e}}_{i,t+1} + (\iota'_r + \rho \mathbf{a}'_i) (\mathbf{I} - \rho \mathbf{\Pi})^{-1} \tilde{\mathbf{x}}_{t+1} \\ \tilde{\mathbf{e}}_{ei} &= \rho \mathbf{a}'_i (\mathbf{I} - \rho \mathbf{\Pi})^{-1} \tilde{\mathbf{x}}_{t+1} \\ \tilde{\mathbf{e}}_r &= \iota'_r (\mathbf{I} - \rho \mathbf{\Pi})^{-1} \tilde{\mathbf{x}}_{t+1} \end{aligned} \quad (10)$$

$\iota_r$  is a selection vector which ‘picks out’ the real interest rate from the VAR, i.e.  $\iota'_r \mathbf{x}_{t+1} \equiv r_{t+1}$ . The left hand side variables in Equation (10) are the news about future dividends on portfolio  $i$ , (related to cyclical economic effects), news about future excess returns, (related to risk premiums) and finally news about future real interest rates, (related to monetary policy effects). The factor innovations are the residuals from the  $k$  individual VAR equations, i.e.:

$$\tilde{\mathbf{e}}_k = \tilde{\mathbf{x}}_{k,t+1} \quad (11)$$

where  $\tilde{\mathbf{x}}_{k,t+1}$  is the  $k$ th row of the innovation vector  $\tilde{\mathbf{x}}_{t+1}$ . Having estimated Equations (6), (7) and (9), and obtained the variables in Equations (10) it is straightforward to calculate the relevant variances and covariances, and hence the betas in Equation (5).

### 3 Data and Empirical Results

The degree of exchange rate and interest rate exposure is examined for the 9 industry portfolios (level 2 sectors) for G7 countries, Canada, France, Germany, Italy, Japan, U.K. and the U.S..<sup>9</sup> The sample runs from January 1975 to September 2007. Table 1 reports the industry correlations across the different G7 countries. Correlations for the industry sectors are generally very high across countries, with the exception of Japan where the correlations are low for a number of industries including basic materials, consumer services, financial, oil & gas and utilities. The state vector contains the real market excess return, the real interest rate and the change in the real exchange rate. The real market excess return and industry excess returns are measured using the change in the log real total market and industry return indexes, incorporating prices and dividends, in excess of the real short term interest rate. The real interest rate is calculated using the three month interbank rate minus the rate of

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<sup>9</sup>Given the level of detailed results from the variance decomposition approach and the number of countries studied, we chose to concentrate on the relatively broad measure of industry portfolios.

inflation calculated from the CPI, and the exchange rate is the real effective exchange rate. All data series are collected from Datastream.<sup>10</sup>

The three state variables enter the VAR as deviations from their mean and the VAR is estimated with a lag length of one. The constraint of the value of  $\rho$  to be the same across each industry portfolio restricts the impact of each factor innovation on revisions to expectations of future real interest rates  $\beta_{ri,k}$  to be the same across all industry sectors.<sup>11</sup> Before addressing the extent of the foreign exchange and interest rate exposure, we investigate the general level of market exposure across the industry level portfolios for all G7 countries. Do the portfolios over or under react to events in the market and are there general levels of homogeneity in terms of levels of exposure?

Table 2 reports the market excess return sensitivities (betas) for each of the industrial sectors in the seven countries as well as industry and country averages. In all cases the betas are significant at the 5% level. As well as all the betas being statistically significant, there are broad similarities in the behavior of common portfolios to changes in market risk across G7 countries. This is particularly clear from the final row which indicates the averages by country. However, there are deviations in industry portfolio risk premia for each country, e.g. the beta range for the U.S. is 0.439 for utilities to 1.395 for technologies. Thus for every 1% increase in market risk, there is a wedge of close to 1% driven between the two U.S. sectors. However, as can be seen by the last column in Table 2 (industry averages) the behavior of the portfolios appear to be consistent across countries, e.g. there are generally large betas for technology and small betas for utilities. Thus the G7 industry portfolios respond in approximately the same manner to changes in market risk, suggesting some degree of homogeneity between these industries. Given the level of homogeneity of market risk premia, to what extent is there likely to be homogeneity of foreign exchange and interest rate exposure across the G7 countries?

### 3.1 Levels of Foreign Exchange & Interest Rate Exposure

We now move on to the assessment of the degree of exposure to interest rates and exchange rates for the industry portfolios. In Table 3, the results for the degree of foreign exchange exposure show that with the exception of Canada, there is little if any sensitivity. This suggests the adoption of the vector autoregression to generate unexpected exchange rate changes does not provide any improvement in terms of identifying direct exposures. Consistent with the prior literature, we report mixed signs in relation to foreign exchange exposure.<sup>12</sup> However, within countries there appears some homogeneity in the sign of the response. For example in Canada industries appear to be heavily exposed, with a positive sign in each case. This would indicate that an unexpected appreciation of the Canadian Dollar coincides with a rise in current expected returns for all Canadian portfolios. The exposure results for Canadian industries are consistent with the results for such firms in Booth and Rotenberg (1990). In contrast, for France and Germany, the results indicate that an unexpected appreciation is

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<sup>10</sup>A detailed account of the data used in the paper is provided in Appendix 2. A limited number of the industry portfolios are only available for a reduced sample and are therefore omitted. These are oil & gas and technology for Germany and utilities for France and the U.K..

<sup>11</sup>This assumption is adopted widely in the decomposition literature applied to stock returns, see Cuthbertson and Nitzsche, 2005.

<sup>12</sup>For example, Choi and Kim (2003), Chue and Cook (2008) and Choi and Jiang (2009) document both positive and negative impacts across firms.

consistent with a fall in portfolio returns. A potential explanation for the differing response of France and Germany with the remaining G7 countries could be due to a combination of the Euro adoption, and these economies being much more export than import orientated in comparison to Italy. Although the extent of foreign exposure is not widespread, a number of industries face significant exposure. These include basic materials which is significant for 3 (Canada, Germany and Italy) out of the 7 nations and utilities for 2 (Italy and Japan) out of 5 countries. However our results do indicate a clear distinction between country and industry based diversification benefits. The industry averages are not statistically significant suggesting diversification across countries removes the impact of foreign exchange exposure, on the other hand, the country averages emphasize that diversifying across industries (within countries) does not remove the exposure.

In terms of the absolute magnitude of the country exposure coefficients, there appears to be a link with the degree of openness of the economy as noted by Friberg and Nydahl (1999) and Hutson and Stevenson (2010).<sup>13</sup> Figure 1 plots the average exposure beta against the log of trade openness, measured as exports plus imports as a percentage of GDP at constant prices, for each country.<sup>14</sup> Consistent with previous findings there is a positive relationship between exposure and trade openness, more open economies such as Canada, France, Germany and Italy have higher estimated exposure elasticities. Overall, the results presented here on foreign exchange exposure, although using a different approach, are generally consistent with the results found to date in the literature (see Choi and Prasad, 1995; Bodnar and Gentry, 1993).

The results for interest rate movements in Table 4 are also mixed with Canada, Japan and the U.K. all showing evidence of widespread exposure, while France, Germany, Italy and the U.S. show very little. With the exception of two cases all significant findings have a negative sign. The lack of significance for U.S. industries is consistent with Sweeney and Warga (1986) and Prasad and Rajan (1995) who also report significance for Utilities and very few other industries, while Prasad and Rajan (1995) also report little evidence of interest rate sensitivity for Germany. Overall, our results imply that, on average, a surprise increase in real interest rates will lead to a downward reduction in industry returns for Canada, Germany, Japan and the U.K. Further, on average, the basic materials, consumer goods, financial and oil & gas industries face significant interest rate exposure irrespective of country, highlighting that diversification across G7 countries does not remove interest rate exposure in these cases.

We now move to the key aspect of our empirical approach, the ability to decompose the avenues of exposure for both exchange rates and interest rates. This decomposition enables us to explicitly identify cash flow effects and therefore actual exposure. Further, several studies highlight the importance of possible nonlinearities (Giddy and Dufey, 1995; Kanas, 1996; Bartram, 2004). This decomposition automatically takes account of any potential nonlinear relations in the level of exposure.

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<sup>13</sup>Following Dominguez and Tesar (2001a,b) and Hutson and Stevenson (2010) we examine absolute exposures rather than signed exposures.

<sup>14</sup>Trade openness is the series 'openk' obtained from the Alan Heston, Robert Summers and Betina Aten, Penn World Tables version 6.3, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. [http://pwt.econ.upenn.edu/php\\_site/pwt\\_index.php](http://pwt.econ.upenn.edu/php_site/pwt_index.php)

## 3.2 Levels of Indirect Exposure

To examine the degree of indirect exposure we decompose the sensitivity terms into news about future cash flows  $\beta_{di,k}$  and news about future excess returns  $\beta_{ei,k}$ . The decomposition clearly identifies the extent of indirect foreign exchange and interest rate exposure for industries across the G7. It is only via the decomposition that the full extent of the foreign exchange exposure in particular is uncovered. Unexpected changes in excess market returns typically have a positive impact on revisions in expectations about both future cash flows and future excess returns. Moreover, the majority of estimated coefficients are statistically significant. Furthermore the absolute value of the cash flow (dividend) betas is much larger than that of the future excess return betas, suggesting changes in stock returns associated with a change in the market excess return are due more to revisions in expectations about future dividends than future excess returns. This suggests, according to Campbell and Vuolteenaho (2004), that the permanent effects on wealth are greater than the transitory effects on wealth and so future investment opportunities are reduced.<sup>15</sup> Of particular note is the degree of homogeneity of the results across both industry and country and the consistency in relation to country-wide and industry-wide responses to market movements.<sup>16</sup>

In relation to foreign exchange exposure, Table 5, what is clear from the decomposition results is that there exists considerably greater levels of exposure than that identified solely by the initial regression analysis in Table 3. The level of foreign exchange exposure is dramatic once we take into account the channels in which the influence occurs. As would be expected open markets, such as Canada, France and Germany are particularly sensitive, but also Japan and the U.S., where little if any exposure was previously identified, now shows small yet statistically significant levels of exposure across all industry categories. However, the nature of the exposure differs between the traditional open versus closed markets. For the open markets, we generally find large negative relationships, while for the closed markets we find low, yet inconsistent sign relationships. However, in the majority of industry cases for the U.S., a Dollar appreciation has an adverse influence on future excess returns and this dominates any cash flow effect. Our results imply that the ‘good’ transitory effects outweigh the ‘bad’ permanent effects. The implication of the excess return channel bearing the brunt of the exposure is that any negative effect on wealth is likely to be transitory and the investment opportunities into the future are likely to be positive. This finding for the US provides further indication of potentially why previous studies have been unable to uncover the extent of foreign exchange exposure.

For economies such as Canada, France and Germany cash flow effects dominate discount rate effects suggesting the existence of exposure is much more significant for the industries involved. These results are entirely consistent with the wide-spread significance of total betas reported for these open economies in Section 3.1. Further as with the direct exposure results, Figure 2 highlights a positive relationship between our estimates of the dividend (cash flow) and excess return (discount rate) betas and trade openness, and this appears more pronounced for the cash flow effect. Although the sensitivity of G7-wide industry exposure displays much heterogeneity, there is general consistency within each country. Further, the severity of the exposure on particular industries within countries is emphasized by the country average effects, with all countries except Japan and the U.K. reporting some significant effect.

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<sup>15</sup>Campbell and Vuolteenaho (2004) refer to this as the ‘bad’ beta outweighs the ‘good’ beta.

<sup>16</sup>Results not tabulated but available from the authors on request.

However despite most industries displaying significant exposure to both cash flow and discount rate news across the G7, industry averages are virtually all insignificant.

Finally, turning to the interest rate exposure, we find consistent results to those reported in Table 4. There is widespread support for the finding that interest rate exposure exists and that both excess returns and cash flow channels are equally important. Generally, the movements of excess returns and cash flows are mixed across countries, with negative effects dominating the U.K. and positive effects dominating the U.S.<sup>17</sup> However, importantly, in terms of average effects both for industries and countries, there is evidence of diversification benefits with only the cash flow news sensitivity significant for the basic materials and oil & gas industries and for France and the U.K..

### 3.3 Further Discussion and Sensitivity Analysis

Although, the application of the decomposition approach to examining foreign exchange exposure is novel, it is clearly consistent with the textbook definition of foreign exposure. In addition, as noted by Chow et al. (1997), separating cash flow and discount rate effects is important in identifying the actual levels of exposure. Given the U.S. is the most heavily examined country in the exposure literature, our decomposition findings are particularly noteworthy. While we might expect open markets, such as Canada and Germany to report extensive levels of exposure, the industry wide levels of U.S. foreign exchange exposure have not been previously identified. Studies that have examined U.S. industry portfolios have found little evidence of exposure, see for example Bodnar and Gentry (1993). While, recent studies have applied the analysis to firm level data and have generally found consistent results, see Choi and Kim (2003) and Choi and Jiang (2009).<sup>18</sup> Our raw exposure results provide consistent results with the literature on the U.S. to date, however it is only when we apply the decomposition that the extent of the exposure is fully identified.

Besides our results indicating evidence of widespread foreign exchange exposure, we also can infer why previous studies have found such weak results, in particular for the case of the U.S.. The key issue from a cross country perspective is that the nature of the exposure differs. We have isolated the exposure of principal interest to managers, the cash flow beta, which represents transaction and operating exposure, and its relationship to the discount rate beta. For open markets, Canada, France and Germany, the role of cash flow effects is complementary, but dominates any discount rate effect. However, in the majority of industry cases for the U.S., the influence of the future excess returns beta, although complementary, dominates any cash flow effect. The implication of the excess return (or discount rate) channel bearing the brunt of the exposure is that any negative effect on wealth is likely to be transitory and the investment opportunities into the future are likely to be positive. This finding for the US provides further indication of potentially why previous studies have been unable to uncover the extent of foreign exchange exposure.

Clearly openness appears to be correlated with our estimated exposures. To interpret this relationship further we explore whether the differences across countries can be explained

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<sup>17</sup>Results not tabulated but available from the authors on request.

<sup>18</sup>Choi and Jiang (2009) separate multinational corporations (MNC) from non-MNC US firms and find that there is considerably larger levels of exposure for non-MNC US firms. The authors highlight the more effective use of hedging tools by MNC's as a potential reason for the different levels of exposure.

by openness or other potential determinants documented in the prior literature. In particular in addition to openness, we investigate competitiveness (Griffin and Stulz, 2001) and international trade (Jorion, 1990; Dominguez and Tesar, 2001b; Pritamani et al., 2004). Table 6 reports the results of univariate and bivariate regressions for both direct and indirect exchange rate exposures. While competitiveness and exports demonstrate some explanatory power, it is only the openness variable which consistently explains the estimated exposures, suggesting the more open the economy the greater the exposure. The results also highlight the particular sensitivity of cash flow exposure relative to discount rate exposure in relation to openness. In line with expectations, determinants of exchange rate exposures do not explain differences in exposure to interest rates.<sup>19</sup>

Within countries, the industry effects are extremely consistent at the level of both raw and decomposed betas. For example for the case of the most open market, Canada, we find consistently high levels of exposure for all industries, while for the U.S., we find consistently low, yet statistically significant, levels of exposure for all industries. For the open markets consumer services, financials and industrials are consistently heavily exposed. Our findings in relation to the type of firms that are particularly exposed to foreign exchange movements are consistent with previous results from Krishnamoorthy (2001). Krishnamoorthy (2001) points to the evidence that firms which operate in relatively more competitive or consumer orientated environments face greater levels of foreign exchange rate exposure. The author presents consistent sectors to those highlighted here, namely financials (banking), consumer goods (retail) and industrials. In all cases the exposure results that we report for these industries are particularly driven by the *permanent* cash flow beta for the open markets. This relationship is plotted in Figure 3. On the other hand, industries such as utilities and oil and gas report relatively low levels of exposure across all countries, with no obvious pattern in relation to openness.

A potential criticism of our approach is that the vast amount of previous work has applied two factor models to examine the extent of foreign exchange exposure. To provide a direct comparison with the existing literature we estimate the Jorion (1990) specification given in Equation (1). In particular, we now have a two factor model including the market and the foreign exchange component. The results for the exchange rate exposure are reported in Table 7 and the beta decomposition in Table 8. Unsurprisingly, the removal of the interest rate factor makes little difference to the magnitude of significance of the exchange rate betas, whether the focus is on direct or indirect effects. The results are entirely consistent with those reported in Tables 3 and 5.

## 4 Conclusion

This study investigates the level of exchange rate and interest rate exposure faced by industries in the G7 economies. We specifically look to isolate two potentially critical issues for the exposure literature.

First, our approach to the measurement of unexpected exposure differs to the majority of the extant literature. A number of theories based on the assumption of efficient markets would suggest that only unanticipated levels of exposure should influence firm or industry

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<sup>19</sup>Results not tabulated but available from the authors on request.

portfolio prices immediately. On the other hand, anticipated changes in exposure should not affect firm or industry portfolio prices, but instead such information should already be priced into the asset by market participants. We adopt a forecasting approach which is popular in the asset pricing literature to determine the level of unexpected exposure. Our approach may be viewed as an extension to the procedures adopted previously by Amihud (1994), Choi et al. (1992) and Gao (2000). Our initial results indicate that this approach yields little in terms of identifying levels of direct exposure.

The second critical element of our analysis is that we investigate the existence of indirect levels of both foreign exchange and interest rate exposure. It is only via the detailed examination of the possible channels of influence, that we can clearly observe the extent of the exposure and the degree of nonlinearity. While the requirement to decompose returns to examine exposure has been highlighted by both textbook definitions of exposure (see Eiteman et al., 2010) and in the empirical literature (see Chow et al., 1997), there has been limited application in the exposure literature to date. The Campbell (1991) decomposition approach adopted here, although novel in this literature, has proven successful in the finance asset pricing literature. Our results for the direct effects of both foreign exchange and interest rate exposure applied to the industry portfolios across the G7 economies are weak, but consistent with those documented previously in the literature. This would suggest that industries face little or no exposure to unexpected changes in exchange rates. It is only when we adopt the beta decomposition that we identify the true extent of foreign exchange and interest rate exposure.

The level of foreign exchange exposure is dramatic once we take into account the channel through which the influence occurs. We find intuitively appealing results that open markets, such as Canada and Germany are particularly sensitive to foreign exchange exposure. However, we also find evidence of widespread foreign exchange exposure for U.S. industries. The key issue from a cross country perspective is that the nature of the exposure differs. We have isolated the exposure of principal interest to managers, the cash flow beta, which represents transaction and operating exposure, and its relationship to the discount rate beta. In the majority of industry cases for the U.S., a Dollar appreciation has an adverse influence on future excess returns and this dominates any cash flow effect. Consistent signs are found for European G7 markets, but the influence on future cash flows dominates. The implication of the excess return channel bearing the brunt of the exposure in the U.S. is that any negative effect on wealth is likely to be transitory and the investment opportunities into the future are likely to be positive. This finding for the U.S. provides further indication of potentially why previous studies have been unable to uncover the extent of foreign exchange exposure. There is considerable variability in the sensitivity of G7 industry-wide exposures, although there is general consistency at the country level. The heterogeneity in foreign exchange exposures for open markets are particularly significant and again is consistent with the previous finding for inter-industry foreign exchange exposure. The influence of foreign exchange exposure appears to transmit via the cash flow channel for the more competitive and open markets. This is particularly the case for financials, consumer goods and industrials.

We establish the importance of the decomposition approach in uncovering the extent of cash flow and discount rate exposure for industries across the G7. We also provide some preliminary indication to the determinants of these exposures. Future work should seek to examine whether the approach yields similarly significant results in firm level data and the determinants of these exposures.



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## 5 Appendix 1

This appendix drives the Campbell-Shiller linearised formula for stock returns and dividend price ratio and the Campbell variance decomposition. For a more detailed derivation see Cuthbertson and Nitzsche (2005) which this summary draws on. The one period real holding period return (portfolio  $i$ ) is derived as ;

$$H_{i,t+1} = \frac{P_{i,t+1} - P_{i,t} + D_{i,t+1}}{P_{i,t}} \quad (12)$$

where  $P_t$  is the real industry portfolio price at the end of period  $t$  and  $D_{t+1}$  is the real dividend paid during period  $t + 1$ . Taking the log of one plus the real holding period return;

$$h_{i,t+1} = \ln(1 + H_{i,t+1}) = \ln(P_{i,t+1} + D_{i,t+1}) - \ln(P_{i,t}) \quad (13)$$

Re-writing where lower cases denote logs;

$$h_{i,t+1} = \ln[\exp(p_{i,t+1}) + \exp(d_{i,t+1})] - p_{i,t} \quad (14)$$

The term in square brackets is a non-linear function in  $p_{i,t+1}$  and  $d_{i,t+1}$  and can be linearized by taking a first order Taylor series expansion around a geometric mean of  $P$  and  $D$ ;

$$h_{i,t+1} \approx k + \rho_i p_{i,t+1} + (1 - \rho) d_{i,t+1} - p_{i,t} \quad (15)$$

where  $\rho_i = P/(P + D)$  and  $k$  is a constant.<sup>20</sup> Imposing the terminal condition that  $\lim_{j \rightarrow \infty} E_t \rho^j p_{i,t+j} = 0$ ,<sup>21</sup> equation (3) can be solved forward to give:

$$p_{i,t} = \frac{k}{1 - \rho} + (1 - \rho) E_t \sum_{j=0}^{\infty} \rho^j d_{i,t+j+1} - E_t \sum_{j=0}^{\infty} \rho^j h_{i,t+j+1} \quad (16)$$

This enables the effect on the portfolio price of a change in the expected portfolio returns to be calculated. Campbell (1991) shows that it is possible to obtain a decomposition of the unexpected return:

$$\begin{aligned} \tilde{h}_{i,t+1} &\equiv h_{i,t+1} - E_t h_{i,t+1} \\ &= (E_{t+1} - E_t) \left\{ \sum_{j=0}^{\infty} \rho^j \Delta d_{i,t+j+1} - \sum_{j=1}^{\infty} \rho^j h_{i,t+j+1} \right\} \end{aligned} \quad (17)$$

by substituting  $p_{i,t}$  and  $p_{i,t+1}$  out of equation (1). Although equation (4) is written in terms of real log portfolio returns, it is possible to define the excess portfolio return over a

<sup>20</sup>Following Cuthbertson and Nitzsche (2005)  $\rho = 0.99$  is adopted for all the countries.

<sup>21</sup>This condition prevents explosive behavior and rules out “rational bubbles”.

short term interest rate as  $e_{i,t+1} \equiv h_{i,t+1} - r_{i,t+1}$  where  $h_{i,t+1}$  is the expected return and  $r_{i,t+1}$  is the real interest rate, such that the innovation in the excess return is given by:

$$\begin{aligned}\tilde{e}_{i,t+1} &= (E_{t+1} - E_t) \left\{ \sum_{j=0}^{\infty} \rho^j \Delta d_{i,t+j+1} - \sum_{j=0}^{\infty} \rho^j r_{i,t+j+1} - \sum_{j=1}^{\infty} \rho^j e_{i,t+j+1} \right\} \\ &= \tilde{e}_{di,t+1} - \tilde{e}_{ri,t+1} - \tilde{e}_{ei,t+1}\end{aligned}\tag{18}$$

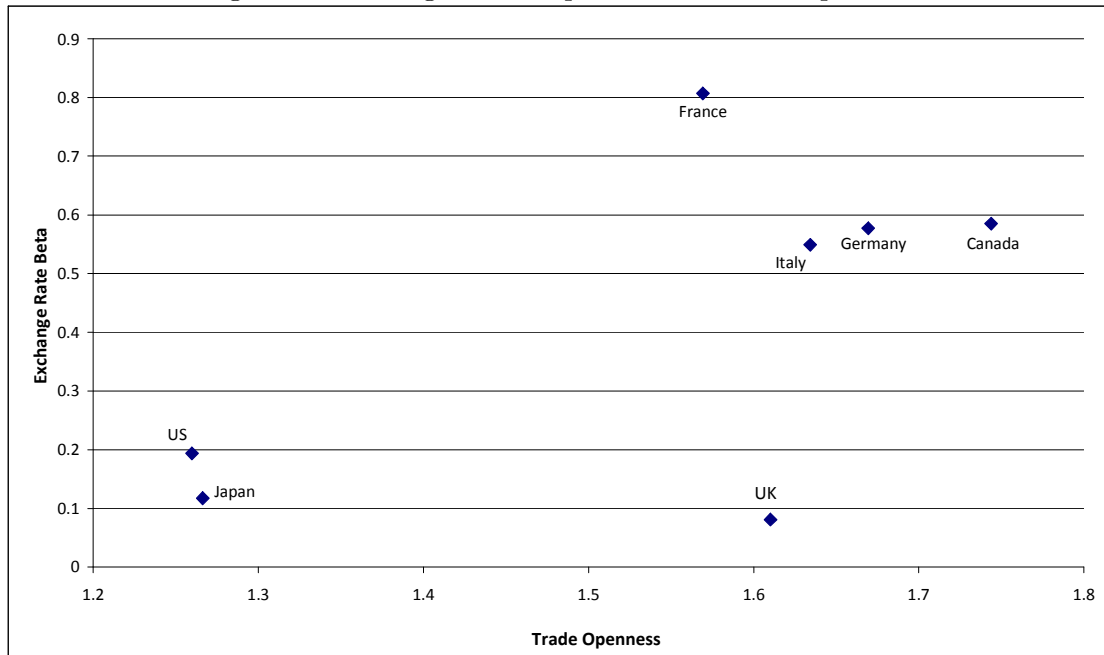
This states that the unexpected excess return on portfolio  $i$ ,  $\tilde{e}_{i,t+1}$  is equal to the news about future dividends on portfolio  $i$ ,  $\tilde{e}_{di,t+1}$ , minus the news about future real interest rates,  $\tilde{e}_{ri,t+1}$ , and the news about future excess returns,  $\tilde{e}_{ei,t+1}$ .

## 6 Appendix 2

	<b>Market</b>	<b>Interest Rates</b>	<b>Foreign Exchange</b>	<b>Prices</b>
<b>Canada</b>	price index (TOTMKCNRI)	money market return (CNI60B)	effective exchange rate (CNI..NEUE)	CPI (CNI64...F)
<b>France</b>	price index (TOTMKFRRI)	Paris IBOR/EURIBOR (FRINTER3)	effective exchange rate (FRI..NEUE)	CPI (FRI64...F)
<b>Germany</b>	price index (TOTMKBDRI)	Frankfurt IBOR/EURIBOR (BDINTER3)	effective exchange rate (BDI..NEUE)	CPI (BDI64...F)
<b>Italy</b>	price index (TOTMKITRI)	inter bank deposit rate/EURIBOR (ITINTER3)	effective exchange rate (ITL..NEUE)	CPI (ITI64...F)
<b>Japan</b>	price index (TOTMKJPRI)	money market return (JPI60B)	effective exchange rate (JPI..NEUE)	CPI (JPI64...F)
<b>UK</b>	price index (TOTMKUKRI)	inter bank rate (UKINTER3)	effective exchange rate (UKI..NEUE)	CPI (UKI64...F)
<b>US</b>	price index (TOTMKUSRI)	inter bank rate (USINTER3)	effective exchange rate (UKI..NEUE)	CPI (UKI64...F)

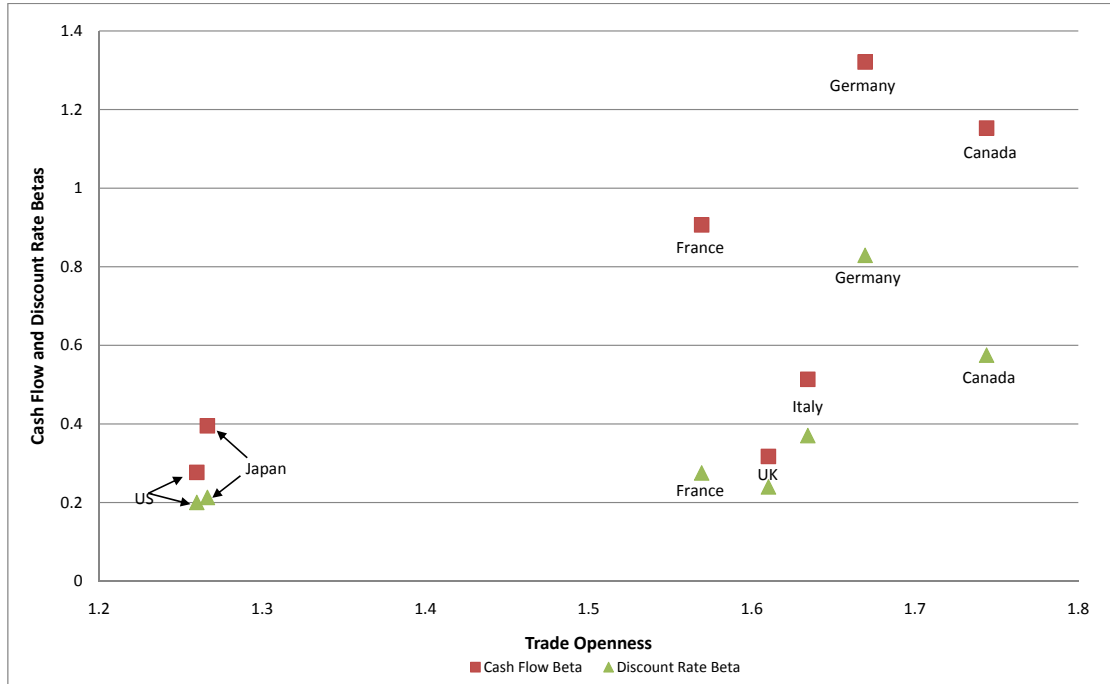
Data Appendix: All Data obtained from Datastream. Figures in parenthesis are Datastream mnemonics.

Figure 1: Exchange Rate Exposure and Trade Openness



This figure plots the mean absolute exchange rate beta for each country against the log of trade openness. Trade openness data (constant prices) were obtained from Penn World Table version 6.3 for the period 1975 – 2007. (Alan Heston, Robert Summers and Betina Aten, Penn World Tables version 6.3, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. [http://pwt.econ.upenn.edu/php\\_site/pwt\\_index.php](http://pwt.econ.upenn.edu/php_site/pwt_index.php)).

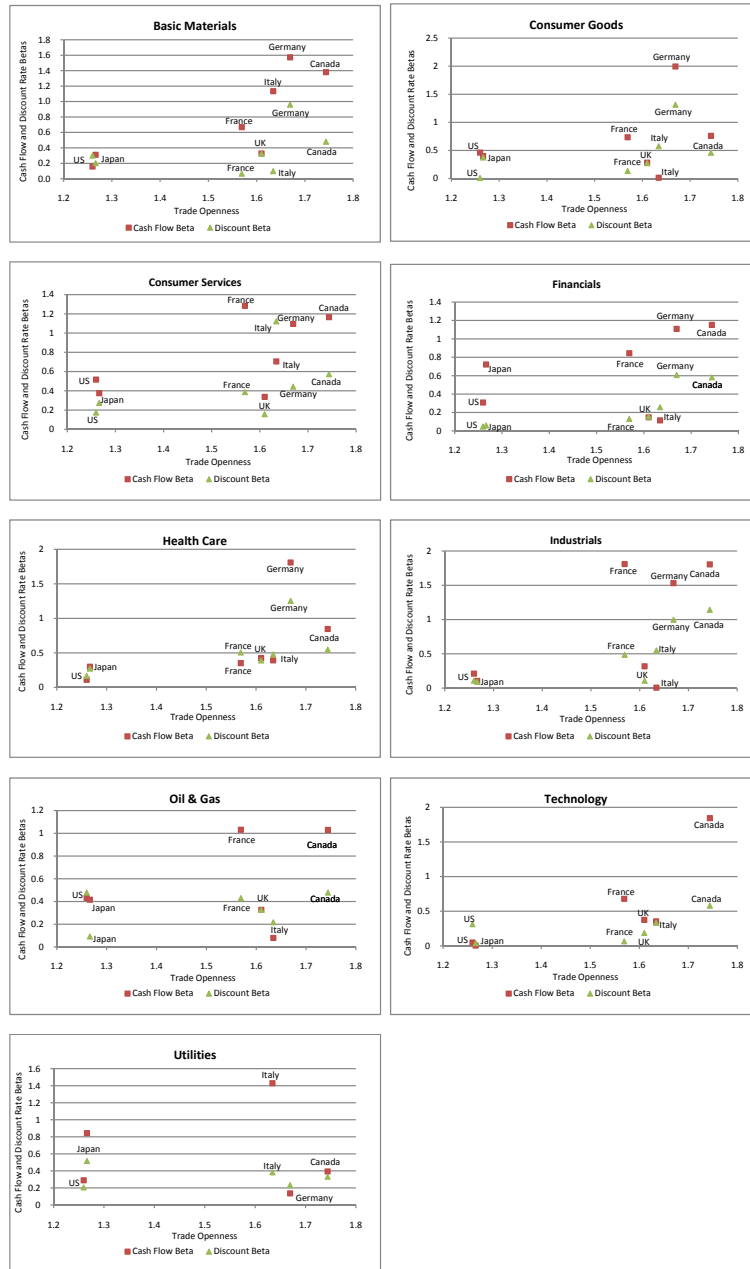
Figure 2: Exchange Rate Exposure Decomposition and Trade Openness



This figure plots the mean absolute cash flow and discount rate exchange rate betas for each country against the log of trade openness. Trade openness data (constant prices) were obtained from Penn World Tables version 6.3 for the period 1975 – 2007. (Alan Heston, Robert Summers and Betina Aten, Penn World Tables version 6.3, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. [http://pwt.econ.upenn.edu/php\\_site/pwt\\_index.php](http://pwt.econ.upenn.edu/php_site/pwt_index.php)).



Figure 3: Industry Exchange Rate Exposure Decomposition and Trade Openness



This figure plots the absolute cash flow and discount rate betas for each country by industry against the log of trade openness. Trade openness data (constant prices) were obtained from Penn World Tables version 6.3 for the period 1975 – 2007. (Alan Heston, Robert Summers and Betina Aten, Penn World Tables version 6.3, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania. [http://pwt.econ.upenn.edu/php\\_site/pwt\\_index.php](http://pwt.econ.upenn.edu/php_site/pwt_index.php)).

**Table 1: Industry Correlations**

<b>Basic Materials</b>	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00						
France	0.968	1.00					
Germany	0.972	0.980	1.00				
Italy	0.904	0.952	0.907	1.00			
Japan	0.487	0.440	0.426	0.551	1.00		
U.K.	0.983	0.983	0.968	0.945	0.513	1.00	
U.S.	0.983	0.952	0.977	0.858	0.413	0.963	1.00
<b>Consumer Goods</b>	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00						
France	0.878	1.00					
Germany	0.897	0.967	1.00				
Italy	0.849	0.887	0.898	1.00			
Japan	0.776	0.944	0.917	0.884	1.00		
U.K.	0.904	0.987	0.962	0.876	0.924	1.00	
U.S.	0.963	0.941	0.941	0.899	0.880	0.953	1.00
<b>Consumer Services</b>	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00						
France	0.950	1.00					
Germany	0.954	0.962	1.00				
Italy	0.918	0.954	0.916	1.00			
Japan	0.464	0.506	0.526	0.513	1.00		
U.K.	0.961	0.947	0.971	0.882	0.544	1.00	
U.S.	0.982	0.957	0.967	0.913	0.460	0.978	1.00
<b>Financial</b>	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00						
France	0.979	1.00					
Germany	0.782	0.853	1.00				
Italy	0.921	0.966	0.941	1.00			
Japan	0.075	0.168	0.251	0.254	1.00		
U.K.	0.954	0.963	0.913	0.967	0.116	1.00	
U.S.	0.971	0.966	0.879	0.956	0.086	0.994	1.00
<b>Health Care</b>	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00						
France	0.974	1.00					
Germany	0.910	0.957	1.00				
Italy	0.843	0.886	0.874	1.00			
Japan	0.666	0.713	0.750	0.7932	1.00		
U.K.	0.952	0.984	0.963	0.932	0.752	1.00	
U.S.	0.960	0.982	0.957	0.915	0.716	0.993	1.00
<b>Industrials</b>	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00						
France	0.756	1.00					
Germany	0.805	0.986	1.00				
Italy	0.590	0.716	0.712	1.00			
Japan	0.553	0.960	0.774	0.850	1.00		
U.K.	0.775	0.973	0.982	0.680	0.789	1.00	
U.S.	0.844	0.969	0.980	0.651	0.693	0.957	1.00

This table reports sample correlations between countries for each industry over the sample period 1975 – 2007.

**Table 1: Industry Correlations [continued]**

<b>Oil &amp; Gas</b>	<b>Canada</b>	<b>France</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00					
France	0.953	1.00				
Italy	0.976	0.982	1.00			
Japan	0.430	0.286	0.369	1.00		
U.K.	0.932	0.987	0.971	0.311	1.00	
U.S.	0.978	0.983	0.986	0.369	0.975	1.00
<b>Technology</b>	<b>Canada</b>	<b>France</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>
Canada	1.00					
France	0.922	1.00				
Italy	0.281	0.223	1.00			
Japan	0.810	0.865	0.347	1.00		
U.K.	0.964	0.916	0.221	0.815	1.00	
U.S.	0.867	0.935	0.182	0.856	0.888	1.00
<b>Utilities</b>	<b>Canada</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.S.</b>	
Canada	1.00					
Germany	0.974	1.00				
Italy	0.936	0.912	1.00			
Japan	0.574	0.530	0.510	1.00		
U.S.	0.943	0.915	0.978	0.594	1.00	

This table reports sample correlations between countries for each industry over the sample period 1975 – 2007.

**Table 2: Real Stock Market Return Exposure**

	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>	<b>Industry Average</b>
Basic Materials	1.087* (0.056)	0.928* (0.029)	0.885* (0.030)	0.967* (0.049)	0.990* (0.034)	1.053* (0.034)	1.081* (0.056)	0.999* (0.029)
Consumer Goods	0.932* (0.132)	1.085* (0.049)	1.064* (0.082)	1.115* (0.056)	0.869* (0.044)	1.101* (0.054)	1.016* (0.053)	1.026* (0.035)
Consumer Services	0.840* (0.044)	0.999* (0.041)	0.854* (0.045)	0.942* (0.063)	0.876* (0.024)	1.050* (0.028)	1.159* (0.033)	0.960* (0.044)
Financial	0.827* (0.054)	0.783* (0.047)	1.088* (0.040)	0.997* (0.021)	1.149* (0.057)	1.073* (0.027)	1.015* (0.041)	0.990* (0.052)
Health Care	0.791* (0.048)	0.820* (0.039)	0.614* (0.042)	0.841* (0.050)	0.691* (0.039)	0.854* (0.035)	0.796* (0.041)	0.772* (0.033)
Industrials	1.224* (0.054)	1.061* (0.039)	1.013* (0.027)	1.007* (0.047)	0.978* (0.038)	1.072* (0.041)	1.115* (0.033)	1.066* (0.031)
Oil & Gas	0.987* (0.069)	0.861* (0.071)		0.759* (0.102)	0.857* (0.077)	0.961* (0.042)	0.768* (0.057)	0.865* (0.039)
Technology	1.254* (0.121)	1.344* (0.076)		0.970* (0.112)	1.127* (0.072)	0.935* (0.104)	1.395* (0.061)	1.171* (0.078)
Utilities	0.431* (0.047)		0.348* (0.037)	0.806* (0.057)	0.628* (0.066)		0.439* (0.052)	0.530* (0.083)
Country Average	0.930* (0.084)	0.985* (0.064)	0.838* (0.102)	0.934* (0.037)	0.907* (0.059)	1.012* (0.030)	0.976* (0.092)	

Results of the sensitivity of each of the 9 industry portfolios to the market return in the G7 countries. All figures in parenthesis are standard errors. A \* denotes significance at 5%.

**Table 3: Real Foreign Exchange Rate Exposure**

	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>	<b>Industry Average</b>
Basic Materials	0.902* (0.249)	-0.606 (0.417)	-0.677* (0.285)	1.081* (0.500)	0.093 (0.160)	-0.017 (0.199)	0.100 (0.192)	0.125 (0.216)
Consumer Goods	0.315 (0.429)	-0.875 (0.573)	-0.737* (0.378)	0.410 (0.493)	-0.041 (0.146)	-0.014 (0.299)	0.431* (0.199)	-0.073 (0.177)
Consumer Services	0.596* (0.197)	-0.900 (0.496)	-0.710* (0.318)	0.266 (0.498)	0.087 (0.132)	0.177 (0.216)	0.301 (0.192)	-0.026 (0.180)
Financial	0.577* (0.187)	-0.717* (0.365)	-0.559 (0.345)	0.221 (0.365)	0.068 (0.181)	0.004 (0.212)	0.220 (0.197)	-0.027 (0.154)
Health Care	0.305 (0.207)	-0.860 (0.455)	-0.612* (0.253)	0.864* (0.381)	0.012 (0.129)	-0.038 (0.170)	0.015 (0.152)	-0.045 (0.195)
Industrials	0.670* (0.248)	-1.327* (0.419)	-0.591 (0.309)	0.392 (0.437)	-0.029 (0.155)	0.208 (0.221)	0.278 (0.188)	-0.057 (0.246)
Oil & Gas	0.559* (0.254)	-0.455 (0.475)		0.132 (0.601)	0.309 (0.214)	-0.005 (0.235)	0.005 (0.178)	0.091 (0.139)
Technology	1.271* (0.498)	-0.717 (0.622)		0.679 (0.632)	0.107 (0.195)	0.185 (0.307)	0.266 (0.235)	0.299 (0.269)
Utilities	0.070 (0.157)		-0.154 (0.191)	0.895* (0.395)	0.311* (0.158)		-0.124 (0.130)	0.199 (0.198)
Country Average	0.585* (0.118)	-0.807* (0.091)	-0.577* (0.075)	0.549* (0.113)	0.102* (0.043)	0.062 (0.038)	0.166* (0.059)	

Results of the sensitivity of each of the 9 industry portfolios to the changes in the real exchange rate in the G7 countries. All figures in parenthesis are standard errors. A \* denotes significance at 5%.

**Table 4: Real Interest Rate Exposure**

	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>	<b>Industry Average</b>
Basic Materials	-1.834* (0.717)	-3.261* (1.076)	-3.136* (0.645)	-2.151 (1.526)	-1.854* (0.574)	-1.652* (0.647)	-1.517 (1.174)	-2.201* (0.442)
Consumer Goods	-1.571 (1.332)	-2.471 (1.318)	-2.885* (0.878)	0.490 (1.864)	-1.539* (0.594)	-2.858* (0.757)	-0.347 (1.038)	-1.597* (0.543)
Consumer Services	-2.353* (0.558)	-3.706* (1.272)	0.858 (0.746)	2.461 (1.652)	-1.408* (0.471)	-1.590* (0.704)	0.150 (1.023)	-0.798 (0.783)
Financial	-1.109 (0.581)	-1.041 (0.954)	-1.463 (0.773)	-2.366 (1.269)	-1.394* (0.575)	-1.380* (0.700)	-0.425 (0.967)	-1.311* (0.367)
Health Care	-1.163* (0.586)	-0.731 (1.092)	0.766 (0.606)	-1.811 (1.988)	-1.632* (0.496)	0.816 (0.601)	-0.579 (0.721)	-0.619 (0.388)
Industrials	-2.225* (0.858)	2.340 (1.272)	-2.345* (0.603)	-0.781 (1.577)	-1.590* (0.611)	1.167 (0.688)	1.511 (0.938)	-0.275 (0.644)
Oil & Gas	-2.506* (0.715)	-1.999 (1.321)		-1.478 (2.071)	-1.719* (0.808)	-2.017* (0.851)	-6.087* (1.037)	-2.634* (0.705)
Technology	-0.080 (1.827)	3.673 (1.928)		-0.418 (3.077)	-1.704* (0.769)	-3.258* (1.036)	-0.380 (1.284)	-0.361 (0.941)
Utilities	-1.304* (0.420)		-1.410 (0.461)	-1.677 (1.431)	1.04 (0.599)		-2.23* (0.859)	-1.116 (0.645)
Country Average	-1.572* (0.254)	-0.899 (0.931)	-1.373* (0.615)	-0.859 (0.513)	-1.311* (0.298)	-1.346* (0.560)	-1.101 (0.712)	

Results of the sensitivity of each of the 9 industry portfolios to changes in the real interest rate in the G7 countries. All figures in parenthesis are standard errors. A \* denotes significance at 5%.

Table 5: Decomposition of the Real Exchange Rate Beta

Variable	Canada		France		Germany		Italy		Japan		U.K.		U.S.		Industry Average	
	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$
Basic Mat.	1.382* (0.251)	0.479* (0.003)	-0.668 (0.430)	-0.065 (0.047)	-1.572* (0.286)	-0.953 (0.010)	1.134 (0.597)	-0.098 (0.098)	0.310 (0.169)	0.201* (0.009)	0.326 (0.259)	-0.325 (0.073)	-0.158 (0.195)	-0.300* (0.009)	0.108 (0.386)	-0.152 (0.171)
Cons. Goods	0.760 (0.447)	0.461* (0.037)	-0.736 (0.576)	0.136* (0.015)	-1.996* (0.412)	-1.316* (0.053)	-0.016 (0.559)	-0.577* (0.083)	-0.400* (0.155)	-0.375* (0.010)	-0.283 (0.335)	-0.273* (0.062)	0.462* (0.223)	-0.010 (0.026)	-0.315 (0.340)	-0.279 (0.216)
Cons. Serv.	1.166* (0.196)	0.572* (0.001)	-1.283* (0.527)	-0.386* (0.052)	-1.095* (0.331)	-0.443* (0.020)	-0.705 (0.581)	-1.122* (0.128)	0.375* (0.142)	0.273* (0.009)	0.337 (0.241)	0.156* (0.042)	0.517* (0.216)	0.174 (0.033)	-0.154 (0.370)	-0.014 (0.154)
Fin.	1.151* (0.189)	0.582* (0.009)	-0.844* (0.395)	-0.130* (0.053)	-1.109* (0.369)	-0.607* (0.033)	0.115 (0.412)	-0.258* (0.077)	0.722* (0.195)	0.059 (0.147)	-0.147 (0.224)	-0.155* (0.021)	0.308 (0.214)	0.047* (0.027)	0.028 (0.305)	-0.066 (0.137)
Health Care	0.846* (0.205)	0.549* (0.004)	-0.352 (0.456)	0.505* (0.034)	-1.808* (0.262)	-1.253* (0.014)	0.392 (0.393)	-0.477* (0.035)	0.300* (0.133)	0.272* (0.004)	-0.425* (0.182)	-0.391* (0.029)	-0.111 (0.157)	-0.167* (0.029)	-0.165 (0.322)	-0.138 (0.243)
Ind.	1.804* (0.271)	1.142* (0.031)	-1.810* (0.460)	-0.486* (0.070)	-1.531* (0.308)	-0.998* (0.009)	-0.008 (0.491)	-0.550* (0.107)	-0.105 (0.167)	-0.092* (0.007)	0.318 (0.256)	0.107* (0.063)	0.211 (0.198)	-0.109* (0.015)	-0.160 (0.459)	-0.141 (0.255)
Oil & Gas	1.030* (0.244)	0.478* (0.034)	-0.882 (0.546)	0.430* (0.147)	-0.080 (0.597)	-0.217* (0.041)	-0.080 (0.597)	-0.217* (0.041)	-0.416 (0.219)	0.092* (0.040)	-0.326 (0.259)	-0.325* (0.073)	-0.432* (0.184)	-0.479* (0.041)	-0.184 (0.265)	-0.004 (0.164)
Tech.	1.844* (0.496)	0.581* (0.018)	-0.678 (0.644)	0.066 (0.047)			0.354 (0.643)	-0.331* (0.163)	0.085 (0.206)	-0.038* (0.013)	0.375 (0.327)	0.186* (0.049)	-0.005 (0.245)	-0.312* (0.018)	0.329 (0.341)	0.025 (0.139)
Util.	0.394* (0.147)	0.332* (0.031)			0.136 (0.199)	0.233* (0.022)	1.429* (0.409)	0.383* (0.023)	0.843* (0.156)	0.517* (0.012)			-0.289* (0.128)	-0.206* (0.014)	0.503 (0.295)	0.252* (0.123)
Country Average	1.153* (0.158)	0.575 (0.076)	-0.907* (0.159)	0.009 (0.124)	-1.282* (0.268)	-0.762* (0.205)	0.247 (0.244)	-0.285* (0.099)	0.191 (0.148)	0.101 (0.086)	0.022 (0.123)	-0.128 (0.085)	0.056 (0.112)	-0.151* (0.067)		

Decomposition of the real foreign exchange rate beta into cash flow and future excess return (discount rate) components of the 9 industry portfolios in each of the G7 countries. All figures in parenthesis are standard errors. A \* denotes significance at 5%.

**Table 6: Determinants of Exposure**

Total exposure $\beta_i$									
Intercept	-0.946*	2.211*	1.218*	2.925*	2.772*	-0.306	-0.598	1.662	0.309
	(0.334)	(0.891)	(0.529)	(0.560)	(0.955)	(1.093)	(0.682)	(1.385)	(1.156)
Open	0.886*					0.826*	0.849*	0.348	0.779*
	(0.217)					(0.239)	(0.227)	(0.349)	(0.236)
Comp.		-2.527*				-0.771			
		(1.248)				(1.250)			
Terms of Trade			-0.008				-0.003		
			(0.005)				(0.005)		
Exports				-0.026*				-0.018	
				(0.006)				(0.009)	
Imports					-0.025*				-0.012
					(0.010)				(0.010)
Adjusted $R^2$	0.213	0.051	0.023	0.249	0.081	0.204	0.204	0.249	0.217
Cash flow exposure $\beta_{di}$									
Intercept	-1.514*	-0.334	0.924	2.513*	2.345	-5.946*	-2.323*	-6.117*	-2.427
	(0.530)	(1.462)	(0.858)	(1.009)	(1.584)	(1.622)	(1.076)	(2.176)	(1.849)
Open	1.430*					1.843*	1.517*	2.380*	1.509*
	(0.344)					(0.354)	(0.359)	(0.549)	(0.378)
Comp.		1.416				5.332*			
		(2.048)				(1.856)			
Terms of Trade			-0.002				0.007		
			(0.008)				(0.008)		
Exports				-0.019				0.032*	
				(0.010)				(0.015)	
Imports					-0.018				0.009
					(0.017)				(0.016)
Adjusted $R^2$	0.219	-0.009	-0.016	0.039	0.002	0.308	0.216	0.268	0.209
Discount rate exposure $\beta_{ei}$									
Intercept	-0.832*	0.878	0.543	1.553*	1.752*	-1.830	-1.260	-2.829*	-0.745
	(0.295)	(0.816)	(0.478)	(0.558)	(0.873)	(0.958)	(0.601)	(1.234)	(1.033)
Open	0.797*					0.890*	0.843*	1.209*	0.789*
	(0.192)					(0.209)	(0.200)	(0.311)	(0.211)
Comp.		-0.689				1.201			
		(1.143)				(1.097)			
Terms of Trade			-0.002				0.003		
			(0.005)				(0.004)		
Exports				-0.012*				0.014	
				(0.006)				(0.008)	
Imports					-0.015				-0.001
					(0.009)				(0.009)
Adjusted $R^2$	0.219	-0.011	-0.016	0.055	0.024	0.222	0.214	0.243	0.205

Results of the regressions of industry exposure measures on potential determinants. Open is Trade Openness from Penn World Tables version 6.3, Comp. is the Global Competitive Index from the World Economic Forum, Terms of Trade, Exports and Imports are Balance of Payments based price indexes from Datastream. All figures in parenthesis are standard errors. A \* denotes significance at 5%.



**Table 7: Real Foreign Exchange Rate Exposure**

	<b>Canada</b>	<b>France</b>	<b>Germany</b>	<b>Italy</b>	<b>Japan</b>	<b>U.K.</b>	<b>U.S.</b>	<b>Industry Average</b>
Basic Materials	0.903* (0.248)	-0.628 (0.418)	-0.673* (0.285)	1.068* (0.506)	0.093 (0.160)	-0.018 (0.198)	0.105 (0.190)	0.122 (0.217)
Consumer Goods	0.295 (0.428)	-0.910 (0.492)	-0.746* (0.379)	0.416 (0.494)	-0.039 (0.146)	-0.014 (0.298)	0.434* (0.197)	-0.080 (0.181)
Consumer Services	0.594* (0.197)	-0.900 (0.496)	-0.711* (0.317)	0.252 (0.506)	0.086 (0.132)	0.176 (0.216)	0.314 (0.189)	-0.027 (0.180)
Financial	0.579* (0.186)	-0.726* (0.364)	-0.550 (0.345)	0.212 (0.367)	0.067 (0.181)	0.004 (0.212)	0.231 (0.195)	-0.026 (0.155)
Health Care	0.303 (0.206)	-0.879 (0.453)	-0.610* (0.253)	0.846* (0.380)	0.011 (0.129)	-0.039 (0.171)	0.030 (0.151)	-0.048 (0.196)
Industrials	0.663* (0.248)	-1.344* (0.418)	-0.594 (0.309)	0.376 (0.440)	-0.028 (0.155)	0.207 (0.220)	0.283 (0.186)	-0.062 (0.248)
Oil & Gas	0.573* (0.258)	-0.523 (0.486)		0.147 (0.586)	0.323 (0.215)	-0.006 (0.239)	-0.014 (0.180)	0.083 (0.151)
Technology	1.261* (0.501)	-0.750 (0.614)		0.583 (0.604)	0.107 (0.195)	0.185 (0.307)	0.275 (0.233)	0.277 (0.268)
Utilities	0.075 (0.157)		-0.155 (0.191)	0.897* (0.396)	0.306 (0.158)		-0.117 (0.128)	0.201 (0.197)
Country Average	0.583* (0.117)	-0.833* (0.088)	-0.577* (0.075)	0.533* (0.111)	0.103* (0.044)	0.062 (0.038)	0.149* (0.061)	

Results of the sensitivity of each of the 9 industry portfolios to the changes in the real exchange rate in the G7 countries using the Jorion (1990) model. All figures in parenthesis are standard errors. A \* denotes significance at 5%.

Table 8: Decomposition of the Real Exchange Rate Beta

Variable	Canada		France		Germany		Italy		Japan		U.K.		U.S.		Industry Average	
	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$	$\beta_{di,\Delta s}$	$\beta_{ei,\Delta s}$
Basic Mat.	1.382* (0.251)	0.479* (0.003)	-0.720 (0.431)	-0.092 (0.014)	-1.633* (0.292)	-0.960* (0.008)	0.108* (0.000)	0.007 (0.041)	0.295 (0.168)	0.202* (0.009)	-0.385 (0.227)	-0.368* (0.032)	-0.200 (0.192)	-0.305* (0.002)	-0.165 (0.352)	-0.148 (0.174)
Cons. Goods	0.802* (0.424)	0.506* (0.051)	-0.739 (0.580)	0.134* (0.014)	-2.039* (0.415)	-1.293* (0.046)	-0.195* (0.574)	-0.611* (0.086)	-0.408* (0.154)	-0.369* (0.011)	-0.273 (0.335)	-0.259* (0.048)	0.418 (0.217)	-0.016 (0.024)	-0.395 (0.319)	-0.278 (0.215)
Cons. Serv.	1.166* (0.196)	0.572* (0.001)	-1.313* (0.528)	-0.403* (0.039)	-1.150* (0.333)	-0.438* (0.019)	-0.735 (0.580)	-0.987* (0.087)	0.358* (0.140)	0.272* (0.009)	0.343 (0.245)	0.167* (0.030)	0.471* (0.205)	0.157* (0.016)	-0.123 (0.355)	-0.094 (0.202)
Fin.	1.165* (0.190)	0.586* (0.005)	-0.873* (0.399)	-0.147* (0.041)	-1.178* (0.370)	-0.628* (0.027)	0.041 (0.415)	-0.171* (0.049)	0.700* (0.193)	0.633* (0.013)	-0.148 (0.229)	-0.152* (0.018)	0.263 (0.206)	0.033* (0.012)	-0.004 (0.312)	0.022 (0.170)
Health Care	0.851* (0.203)	0.548* (0.004)	-0.395 (0.456)	0.483* (0.004)	-1.865* (0.265)	-1.256* (0.014)	0.361 (0.420)	-0.485* (0.020)	0.281* (0.131)	0.270* (0.003)	-0.421* (0.186)	-0.382* (0.018)	-0.155 (0.148)	-0.185* (0.003)	-0.192 (0.328)	-0.144 (0.242)
Ind.	1.799* (0.272)	1.136* (0.029)	-1.858* (0.460)	-0.514* (0.046)	-1.583* (0.312)	-0.989* (0.004)	-0.033 (0.489)	-0.409* (0.055)	-0.117 (0.161)	-0.089* (0.007)	0.331 (0.257)	0.124* (0.042)	0.167 (0.193)	-0.116* (0.008)	-0.185 (0.466)	-0.122 (0.250)
Oil Gas	1.068* (0.249)	0.495* (0.015)	-1.032* (0.530)	-0.509* (0.057)		-0.044 (0.179)	-0.191* (0.006)	0.472* (0.226)	0.149* (0.016)	0.149* (0.016)	-0.304 (0.254)	-0.298* (0.018)	-0.467* (0.179)	-0.453* (0.001)	-0.051 (0.301)	-0.134 (0.158)
Tech.	1.831* (0.502)	0.570* (0.001)	-0.694 (0.645)	0.057 (0.042)		0.210 (0.554)	-0.373* (0.011)	0.066 (0.204)	-0.040* (0.013)	-0.040* (0.013)	0.380 (0.331)	0.195* (0.040)	-0.048 (0.236)	-0.323* (0.004)	0.291 (0.343)	0.014 (0.143)
Util.	0.412* (0.148)	0.337* (0.029)			0.079 (0.205)	0.235* (0.022)	1.256* (0.414)	0.359* (0.022)	0.806* (0.155)	0.500* (0.006)			-0.332* (0.126)	-0.214* (0.005)	0.444 (0.276)	0.243* (0.122)
Country Average	1.127* (0.168)	0.577* (0.074)	-0.953* (0.160)	-0.124 (0.123)	-1.338* (0.267)	-0.761* (0.203)	0.108 (0.176)	-0.318* (0.128)	0.273* (0.128)	0.170 (0.102)	-0.060 (0.124)	-0.122 (0.087)	0.013 (0.111)	-0.158* (0.064)		

Decomposition of the real foreign exchange rate beta into cash flow and future excess return (discount rate) components of the 9 industry portfolios in each of the G7 countries. State vector based on the two factor Jorion (1990) model. All figures in parenthesis are standard errors. A \* denotes significance at 5%.